B2

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 907 002 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
07.04.1999 Bulletin 1999/14

(51) Int Cl.6: E21B 19/00, E21B 17/01

(21) Application number: 98307503.7

(22) Date of filing: 16.09.1998

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 16.09.1997 US 931180

(71) Applicant: Deep Oil Technology, Incorporated
Houston, Texas 77079-1709 (US)

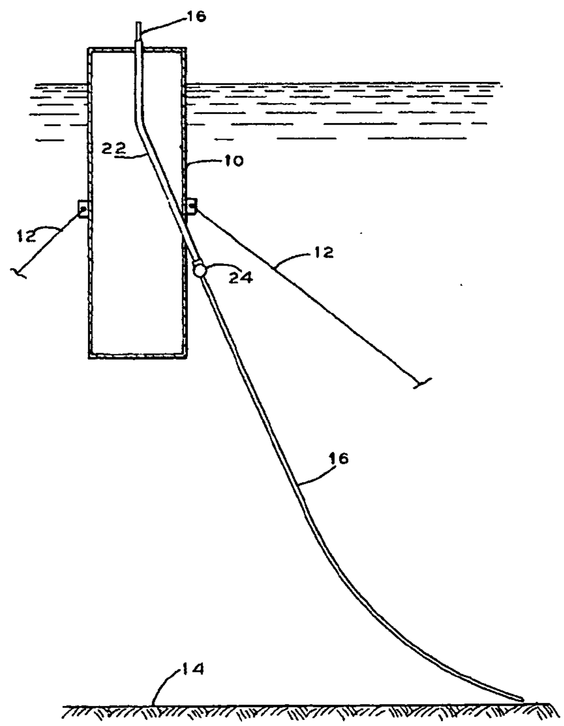
(72) Inventor: Finn, Lyle David
Sugar Land, Texas 77479 (US)

(74) Representative: Pilch, Adam John Michael
D. YOUNG & CO.,
21 New Fetter Lane
London EC4A 1DA (GB)

(54) **Catenary riser supports**

(57) A catenary riser support, for a floating offshore structure (10), that receives the riser (16) and is attached to the floating offshore structure (10). The catenary riser support is formed from a tube (22) that is rigidly attached to the floating structure (10) and a flex joint (24) in line with the catenary riser (16). The tube (22) includes a gradual bend that complements the natural catenary curve of the catenary riser (16). A pipe adaptor (26) attached in line with the flex joint (24) and riser (16) allows the flex joint (24) to be pulled up against the tube (22). The flex joint (24) allows the catenary riser (16) to move relative to the floating structure (10).

FIG. 1



EP 0 907 002 A2

Description

[0001] This invention generally relates to the production of hydrocarbons from subsea formations, and more particularly to supports for riser pipes used in such production.

[0002] In the offshore drilling and production industry, a pipe is often used to carry product (oil or natural gas) from the offshore production site to a collection and storage facility, which may be a tanker or an on shore facility. For offshore structures that rest on the sea floor, such as a jacket or compliant tower, the flexing effect of environmental conditions such as waves and currents have a minimal effect on the design considerations when connecting the pipe to the offshore structure. However, for floating offshore structures, the design of the interface between the pipe and offshore structure must take into account the bending motions, and resulting fatigue and stresses, that the pipe and interface must endure during the life of the structure. The steel catenary pipeline riser approach is generally considered as the most cost effective means for transporting products to and from floating offshore production vessels.

[0003] For a floating structure such as a TLP (tension leg platform) or a semi-submersible, the typical configuration of this riser is for the pipe to be suspended from the side of the floating vessel from a support platform that is located just below the water surface (such as fifty to one hundred feet, or 15 to 30m). Typically the pipe leaves the support platform at an angle from the vertical of between five and twenty-five degrees and curves upward along its length until the pipe becomes tangent with the sea floor some distance away from the floating vessel. Once the steel catenary pipe is installed with its upper end resting on the support platform, the pipe is connected to other piping previously installed on the floating vessel. This connection is typically made with the aid of divers which can be accomplished quite easily, since the support platform is near the water surface.

[0004] There are several disadvantages with this support structure for the steel catenary riser when used with a floating vessel such as a spar, which may have a draft as deep as six hundred and fifty feet (200m). Typically, the mooring lines for the spar are attached to fairleads located several hundred feet below the water surface. Thus, the steel catenary risers, if supported nearer the water surface, would be required to be installed between the mooring lines. In addition, when the risers are supported near the water surface, the upper portion of the riser is subjected to large wave and current loads which can produce over stressing and cause undesirable fatigue damage.

[0005] These two disadvantages can be overcome with a spar floating vessel by supporting the end riser much deeper in the water near the keel of the spar. However, if this approach is employed, the use of divers to connect the riser pipe to the piping previously installed on the spar would be very difficult and costly. One solution, proposed in our European Patent Application No. EP-A-0 825 325, employs a flexible pipe-in-pipe support system wherein the steel catenary riser pipe is pulled up through an outer flexible support pipe. This arrangement works well with an open type of floating structure such as that described in US Patent No. US-A-5 558 467, but becomes more difficult with a closed floating structure such as that described in US Patent No. US-A-4 702 321. With a flexible pipe-in-pipe support arrangement, the outer pipe at the last support point on the floating structure is contained within a guide that permits angular motions of the support pipe and riser pipe. It would be virtually impossible to seal this last support pipe against water to maintain the buoyancy required to install the closed floating structure.

[0006] Respective aspects of the invention are set out in claims 1 and 4.

[0007] A preferred embodiment of the invention provides a catenary riser support, for a floating offshore structure, that receives the catenary riser and is attached to the floating offshore structure. The catenary riser support is formed from a tube that is rigidly attached to the floating structure and a flex joint in line with the catenary riser. The tube includes a gradual bend that complements the natural catenary curve of the catenary riser. A pipe adaptor attached in line with the flex joint and riser allows the flex joint to be pulled up against the tube. The flex joint allows the catenary riser to move relative to the floating structure and thus minimizes bending stresses and potential fatigue damage in the upper portion of the riser.

[0008] The invention will now be described by way of example with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Fig. 1 is a side view that illustrates an embodiment of the invention on a floating offshore structure;
Fig. 2 is an enlarged schematic illustration of the embodiment of Fig. 1; and
Fig. 3 is an enlarged view of the circled area in Fig. 2.

[0009] In Fig. 1, a floating offshore structure 10 is held in position by a plurality of mooring lines 12. The mooring lines 12 are attached at one end to the floating structure 10 and at the opposite end to anchors or pilings (not shown) in the sea floor 14. A catenary riser 16 extends from the sea floor 14 up to the floating structure 10 and is received in and supported by a catenary riser support.

[0010] As best seen in Fig. 2, the catenary riser support is generally comprised of a tube 22 and a flex joint 24.

[0011] The tube 22 is bent at a preselected angle complementary to the natural curve of the catenary riser 16. In the industry, such a bend is commonly referred to as a J-bend. Therefore, for the sake of easy reference the tube 22 may also be referred to as a J-tube. The tube

22 is provided with an internal diameter sized to receive the catenary riser 16. Tube 22 is also sized in length and attached to the floating offshore structure 10 at a preselected depth such that the upper end of tube 22 extends to the upper end of the floating structure 10 and the lower end of the tube 22 extends to the side of the floating structure 10 at a preselected angle that is complementary to the natural catenary curve of the catenary riser 16. Tube 22 is rigidly attached to the floating structure 10 and is designed to be non-flexing such that flexing is accommodated by flex joint 24. Tube 22 may penetrate the offshore structure 10 such that the upper end of the tube 22 exits the upper end of floating structure 10 at any preselected location on the upper end of floating structure 10. In this arrangement, it is necessary that the penetration point of the lower end of tube 22 be sealed to prevent the entry of water into floating structure 10, which would adversely affect the ballast situation.

[0012] As seen in Fig. 2 and 3, flex joint 24 is positioned at the lower end of tube 22. Flex joint 24 is received in line in catenary riser 16 such that the product flows through the flex joint 24. Pipe adaptor 26 is attached to the lower end of the upper section 16A of catenary riser 16 and flex joint 24. The upper end of the lower section 16B of catenary riser 16 is attached to the lower end of the flex joint 24. Fig. 3 also illustrates an optional ball valve 28 received in line between the lower section 16B of catenary riser 16 and the flex joint 24. Ball valve 28 is used to selectively control product flow through catenary riser 16.

[0013] In operation, flex joint 24 and ball valve 28 are added in line to catenary riser 16 as it is laid on the sea floor 14, when the length of catenary riser 16 is appropriate for raising it up to the floating structure 10. Pipe adaptor 28 and the upper section 16A of catenary riser 16 are then attached in line with the flex joint 24 and the upper section 16A of catenary riser 16 is pulled up through tube 22 until catenary riser 16 extends above the upper end of tube 22 and the pipe adaptor is pulled against the lower end of tube 22. Flex joint 24 allows the catenary riser 16 to move relative to the floating structure and thus minimizes bending stresses and potential damage in the upper section 16A of the catenary riser 16. Flex joints are generally well known in the industry and flex joint 24 should only be considered as an example of a suitable flex joint that may be used as part of the invention.

[0014] An advantage of the invention is that it allows the catenary riser 16 to be supported at a depth on the floating structure where the induced stresses in the entire riser are reduced. Thus, the potential for fatigue damage is minimized. Another advantage is that the gradual bending of the tube 22 permits the passage of internal pipe cleaning "pig" elements. Also, the upper end of the riser pipe is above the water in the platform and provides access for inserting flow maintenance items into the pipeline such as pipe cleaning "pigs" and coiled tubing. The invention also allows the riser to be brought up through the center of a closed floating structure without the danger of flooding the structure as referred to for other catenary riser supports. Directing the riser through the center of the floating structure also minimizes the external modifications required to receive a side mounted riser support.

[0015] Because many varying and differing embodiments may be made within the scope of the inventive concept herein taught and because many modifications may be made in the embodiment herein described, it is to be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.

Claims

1. A support for a catenary riser (16) in a floating offshore structure (10) for producing hydrocarbons, in which the catenary riser (16) extends from the sea floor (14) to the floating offshore structure (10), the support comprising:

   a tube (22) rigidly attached to the floating offshore structure (10) at a preselected depth, said tube (22) being bent at a preselected angle complementary to the natural curve of the catenary riser (16) and sized to receive the catenary riser (16); and
   a flex joint (24) received in the catenary riser (16) and positioned at the lower end of said tube (22).

2. A catenary riser support according to claim 1, wherein said tube (22) is designed to be non-flexing.

3. A catenary riser support according to claim 1 or claim 2, wherein said tube (22) penetrates the interior of the floating structure (10).

4. A support for a catenary riser (16) in a floating offshore structure (10) for producing hydrocarbons, in which the catenary riser (16) extends from the sea floor (14) to the floating offshore structure (10), the support comprising:

   a non-flexing tube (22) rigidly attached to and penetrating the interior of the floating offshore structure (10) at a preselected depth and extending upward in the floating structure (10) so as to exit at a preselected position, said tube (22) being bent at a preselected angle complementary to the natural curve of the catenary riser (16) and sized to receive the catenary riser (16); and
   a flex joint (24) received in the catenary riser (16) and positioned at the lower end of said tube (22).

FIG. 1

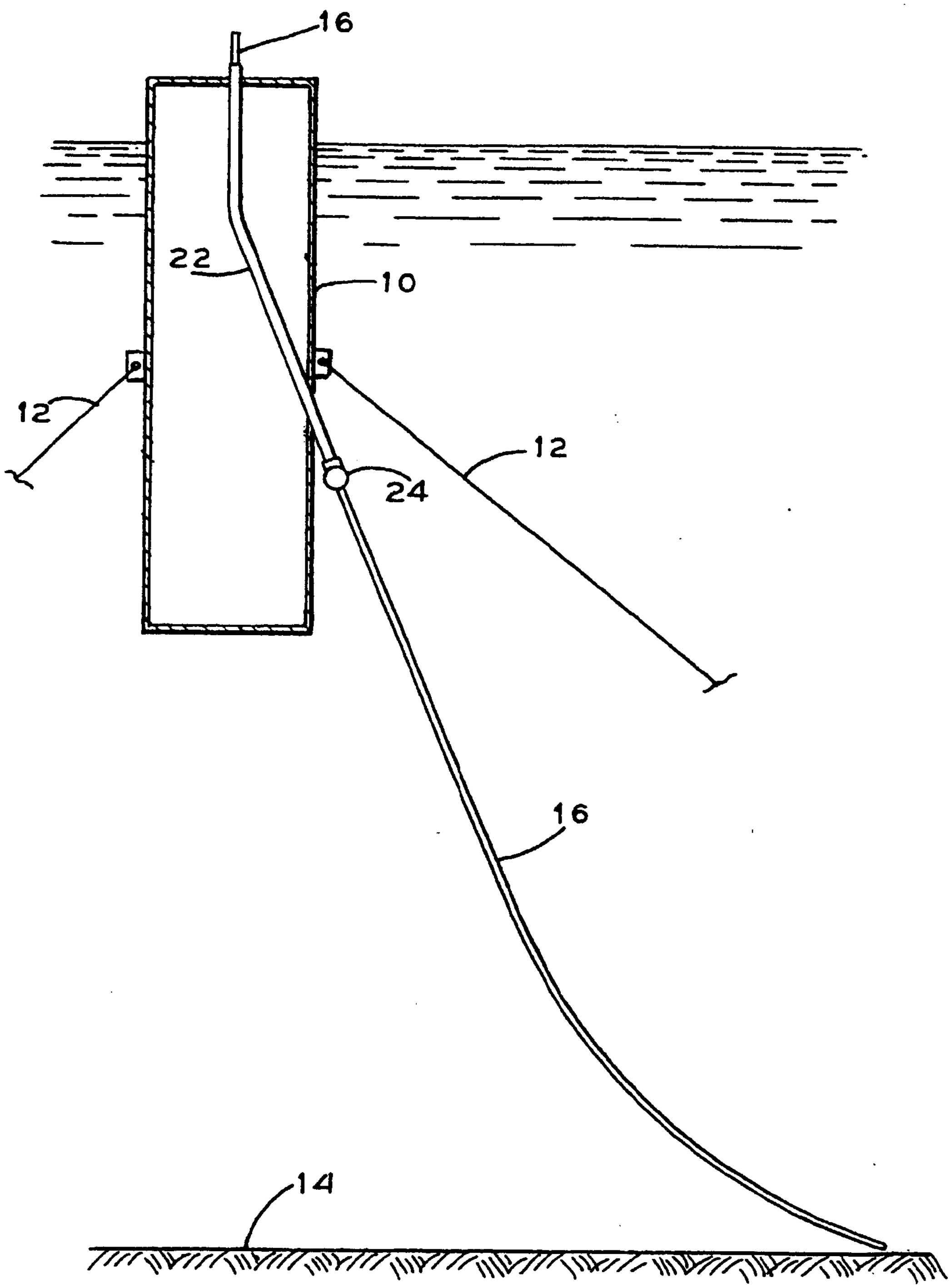


FIG.2

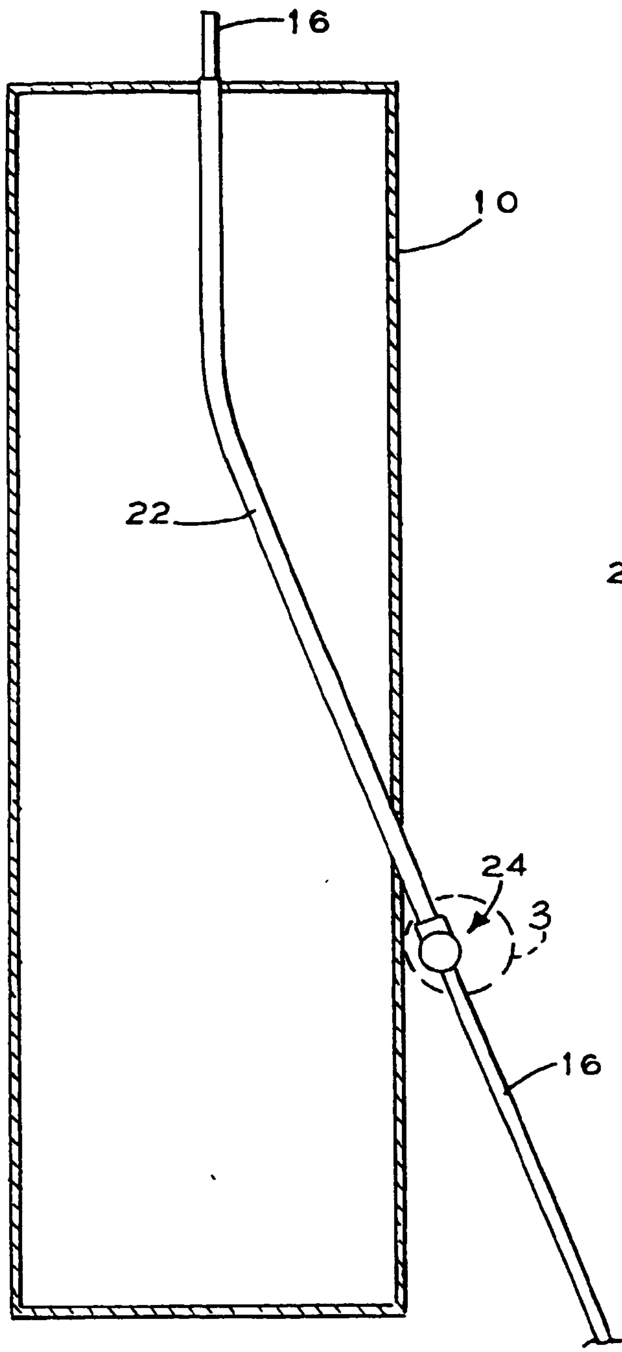
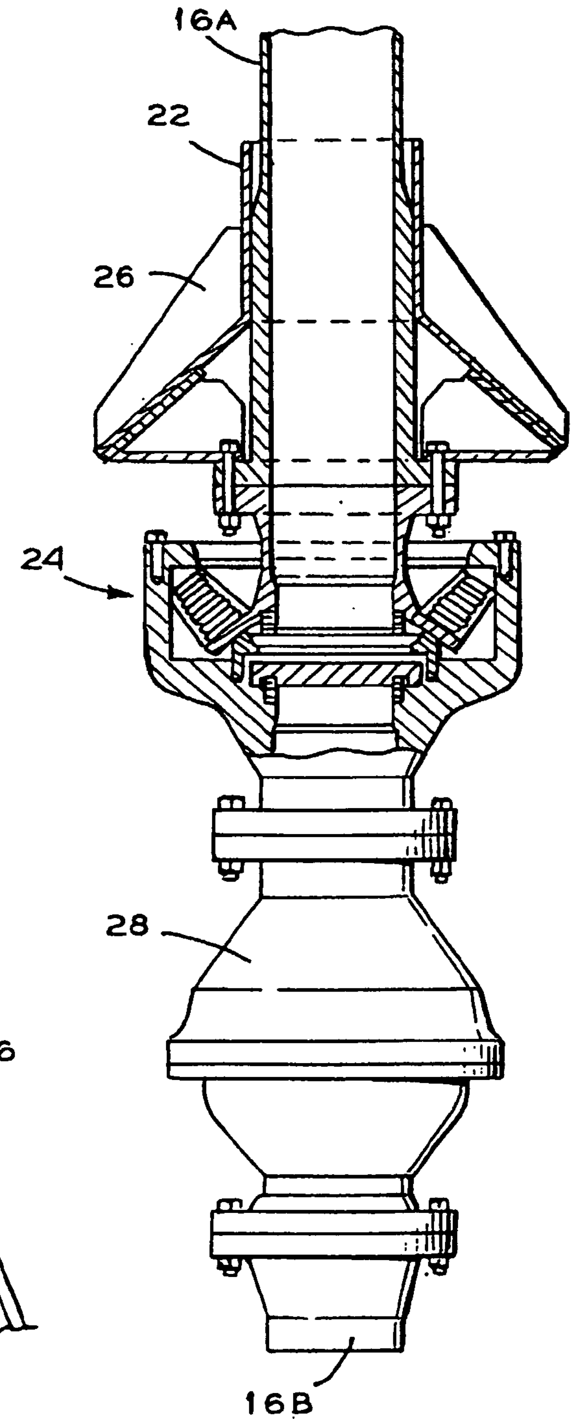


FIG.3



(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 907 002 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
12.07.2000 Bulletin 2000/28

(43) Date of publication A2:
07.04.1999 Bulletin 1999/14

(21) Application number: 98307503.7

(22) Date of filing: 16.09.1998

(51) Int Cl.7: **E21B 19/00**, E21B 17/01

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 16.09.1997 US 931180

(71) Applicant: **Deep Oil Technology, Incorporated**
Houston, Texas 77079-1709 (US)

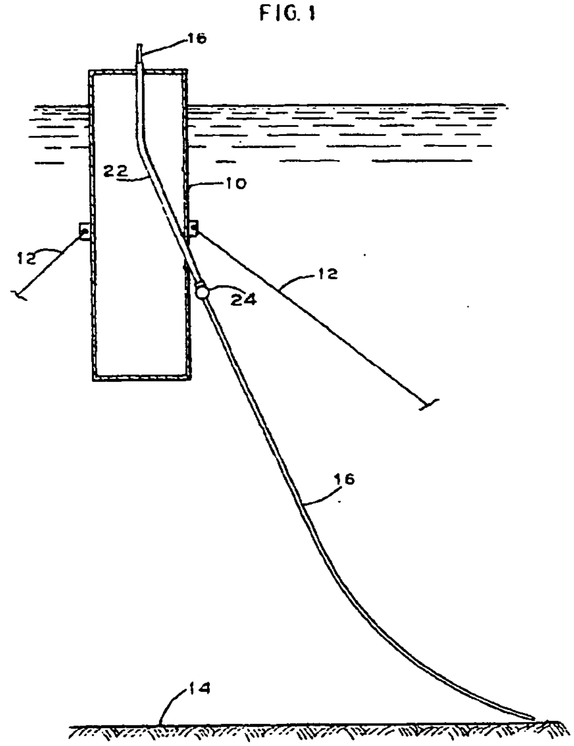
(72) Inventor: **Finn, Lyle David**
Sugar Land, Texas 77479 (US)

(74) Representative: **Pilch, Adam John Michael**
D. YOUNG & CO.,
21 New Fetter Lane
London EC4A 1DA (GB)

(54) Catenary riser supports

(57) A catenary riser support, for a floating offshore structure (10), that receives the riser (16) and is attached to the floating offshore structure (10). The catenary riser support is formed from a tube (22) that is rigidly attached to the floating structure (10) and a flex joint (24) in line with the catenary riser (16). The tube (22) includes a gradual bend that complements the natural catenary curve of the catenary riser (16). A pipe adaptor (26) attached in line with the flex joint (24) and riser (16) allows the flex joint (24) to be pulled up against the tube (22). The flex joint (24) allows the catenary riser (16) to move relative to the floating structure (10).

FIG. 1



EP 0 907 002 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 30 7503

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 269 629 A (LANGNER CARL G) 14 December 1993 (1993-12-14) * column 2, line 9 - line 27; figure 7 * ---	1,2	E21B19/00 E21B17/01
X	WO 93 07048 A (NORSK HYDRO AS ;NORSK HYDRO TECHNOLOGY (NL)) 15 April 1993 (1993-04-15) * claims 1,3; figure 2 * ---	1-4	
X	US 5 615 977 A (SIMIC RAJKO M ET AL) 1 April 1997 (1997-04-01) * column 7, line 24 - line 44; figures 7,1 * -----	1-4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 May 2000	Dantinne, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 98 30 7503

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

16-05-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5269629 A	14-12-1993	NONE	
WO 9307048 A	15-04-1993	NO 177543 B	26-06-1995
		CA 2094699 A	31-03-1993
		CN 1073144 A,B	16-06-1993
		DE 69206779 D	25-01-1996
		DE 69206779 T	05-06-1996
		EP 0558741 A	08-09-1993
		FI 932455 A	28-05-1993
		US 5336020 A	09-08-1994
US 5615977 A	01-04-1997	AT 181138 T	15-06-1999
		AU 7871294 A	27-03-1995
		BR 9405579 A	08-09-1999
		CN 1118618 A	13-03-1996
		DE 69419000 D	15-07-1999
		EP 0666960 A	16-08-1995
		WO 9507405 A	16-03-1995

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82